Capstone Turbine Corporation • 21211 Nordhoff Street • Chatsworth • CA 91311 • USA
Telephone: (818) 734-5300 • Facsimile: (818) 734-5320 • Website: www.microturbine.com

Work Instructions

Commissioning Checklist Procedures
Capstone MicroTurbine

Purpose and Scope

This document describes the commissioning checklist procedures for the Capstone MicroTurbine systems.

NOTE	The procedures in this document must be performed BEFORE completing the MicroTurbine Commissioning Checklist (460006).

Guidelines

This document presents information sufficient to allow an Authorized Service Provider (ASP) to properly verify that the MicroTurbine installation has been performed correctly and accept site responsibility.

Before taking responsibility of the system and submitting the Commissioning Checklist to Capstone, the ASP must perform and satisfy the procedures in this document.

Refer to the following table for a list of reference documents as required.

Part No	Description
410000	Capstone Model C30 Electrical Technical Reference
410001	Capstone Model C60 Electrical Technical Reference
410002	Capstone MicroTurbine Fuel Requirements Technical Reference
410009	Capstone MicroTurbine Electrical Installation Technical Reference
410024	Capstone PowerServer CPS100 Technical Information
410030	Capstone Model C30 Electrical, HEV Model Technical Reference
410031	Capstone Model C60 Electrical, HEV Model Technical Reference
410034	Capstone MicroTurbine Installation and Permitting Guidelines
410039	Dual Mode Controller Technical Reference
460021	Capstone MicroTurbine Installation Checklist
480002	Landfill/Digester Gas Application Guide
512000	Capstone Model C30 Fuel Gas Booster Application Notes
512001	Capstone Model C60 Fuel Gas Booster Application Notes

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Safety Precautions

Only Capstone Authorized Service Providers (ASP's) should open the MicroTurbine and other equipment connected to the MicroTurbine. The systems can include multiple sources of power.

Observe and adhere to the safety precautions listed below when servicing your MicroTurbine. Read and become familiar with the Safety Precautions and Instructions contained within the MicroTurbine documents. Before servicing:

- ❑ Check to ensure that the inlet fuel supply is SHUT OFF
- ❑ Always check to ensure that your MicroTurbine is de-energized from the utility. Isolate and lock out the utility (if applicable).
- ❑ Isolate and lock out any other sources of power to the MicroTurbine. For example, connections to the solid state relays in the MicroTurbine Communications Bay.
- ❑ Open the Stand Alone battery circuit breaker, lock it in the OFF position, and then unplug the battery cable.
- ❑ Wait at least five minutes after disconnection from utility before servicing to allow for electrical energy dissipation.
- ❑ Verify that no voltage is present on any electrical terminals.
- ❑ Never work on energized equipment.
- ❑ Observe all safety precautions to prevent Injury or death.

NOTE	In the following work instructions, if you cannot check the Yes/No answers as indicated, make sure the related issues are fixed before commissioning the system.

Site Evaluation

1. Completed a thorough inspection using the Capstone MicroTurbine Installation Checklist (460021)? ☐ Yes
2. Made any adjustments or additions required to the existing installation before commissioning the system? ☐ Yes

NOTE	If recommended changes have not been made, record them as discrepancies on the last page (Certification page) of the Commissioning Checklist (460006).

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Mechanical Procedures

1. Is there adequate drainage around the MicroTurbine to prevent standing water? ☐ Yes
2. Model C30 Standard Package: Is the MicroTurbine installed on a surface that allows the cart to be rolled out? ☐ Yes
3. Clearances:
   a) Model C30 Standard Package: When the cart is rolled out, is there adequate room to access all components, including rolling the cart out far enough to get into the enclosure behind the cart if necessary? ☐ Yes
   (Recommended clearances in mm/in: Front 1575/62, Side 762/30, Rear 914/36.)
   b) Model C30 Industrial Package: Is there adequate clearance to remove the panels to access all components, including access to the front and the rear of the system? ☐ Yes
   (Recommended clearances in mm/in: Front 914/36, Side 762/30, Rear 914/36.)
   c) Model C60: Is there adequate clearance to open the front cover or remove the panels to access all components, including access to the rear of the system? ☐ Yes
   (Recommended clearances in mm/in: Front 1651/65, Side 762/30, Rear 914/36.)

Air Intakes and Exhaust

1. Is the air intake free of obstructions and debris? ☐ Yes
2. Is there any external ducting limiting air flow? ☐ No
3. Is the exhaust stack clear of obstructions, including the area above the exhaust (roofs, overhangs, etc.)? ☐ Yes
4. Is there a minimum of 200 mm (8 inches) clearance around all exhaust piping? ☐ Yes
5. If any exhaust equipment is installed beyond the Capstone rain flapper:
   a) Is the back pressure less than 203 mm (8 inches) of water? ☐ Yes
   b) If heat recovery system is installed:
      - Is the heat exchanger exhaust free of obstructions? ☐ Yes
      - Are one-way butterfly valves/backflow dampers installed? ☐ Yes
      - Do they prevent reverse air flow to MicroTurbine? ☐ Yes
      - If not, are proper fault wiring interlocks installed? ☐ Yes

Integrated CHP System

1. Has the pressure relief valve been plumbed per the local codes? ☐ Yes
2. Is the water pump connected to the MicroTurbine? Power ☐ Yes, Start/Stop ☐ Yes

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Fuel System

1. Is there a manual shutoff valve and fuel filter installed upstream of the MicroTurbine fuel connection? ☐ Yes
2. Is there a separate fuel regulator installed upstream of each MicroTurbine fuel connection? ☐ Yes

NOTE	Each MicroTurbine requires a separate fuel regulator.

   a) Does the line pressure meet the Capstone specifications in the MicroTurbine Fuel Requirements Technical Reference (410002)? ☐ Yes

   b) Is the orifice size of the regulator at least 17 mm (0.75 inch)? ☐ Yes

   c) Is the piping run length between the fuel option kit (or independent pressure regulator) and MicroTurbine fuel inlet between 12 inches and 8 feet ? ☐ Yes

3. Are all fuel gas fittings tight and leak proof? ☐ Yes
4. Is there a pressure relief valve installed upstream of the MicroTurbine fuel connection? ☐ Yes

   a) Is the pressure relief valve set to 15 psig for a Low Pressure or 80 psig (C60) [or 77 psig (C65)] for a High Pressure system? ☐ Yes

5. Does the fuel type meet the Capstone specifications in the MicroTurbine Fuel Requirements Technical Reference (410002)? ☐ Yes

External Gas Compressor

If an external gas compressor is installed, is the Run/Stop wiring connected to the correct UCB relay? ☐ Yes

CAUTION	Configure the output relay software settings BEFORE applying power to the external gas compressor to prevent damage to MicroTurbine components. Refer to the Model C30 Fuel Gas Booster Application Notes (512000) or Model C60 Fuel Gas Booster Application Notes (512001) for details.

Electrical Procedures

Grounding

1. Is the chassis of the MicroTurbine connected to an earth ground (applies to all MicroTurbine configurations)? ☐ Yes
2. Is there one and only one neutral to ground connection point, even on the MultiPac? ☐ Yes

NOTE	Refer to the Electrical Installation Technical Reference (410009) as required.

Power Connections

1. Are the AC output phase wires and neutral wire connected to the terminal block on the MicroTurbine properly? ☐ Yes
2. Are control wires run in a separate conduit from the power cables? ☐ Yes

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

3. Is there a disconnect device installed within sight of the MicroTurbine? ☐ Yes
4. If Stand Alone:
   a) Is the load applied to MicroTurbine less than the power shown on Derating curves for Ambient Temperature, Back Pressure, and Ambient Pressure? ☐ Yes
   b) If motors are installed, is the inrush current of motors/soft-starting system or maximum load current less than the MicroTurbine specification? ☐ Yes (Refer to the Model C30 Electrical Technical Reference [410000] or Model C60 Electrical Technical Reference [410001] as required.)

Dual Mode Controller Procedures

If a Capstone Dual Mode Controller (DMC) is used with the MicroTurbine, commission the DMC module as follows:

Requirements

- ❑ Circuit Breaker
- ❑ Digital Multimeter (DMM)
- ❑ External 12 VDC or 24 VDC Power Supply

Procedure

1. Make sure there are no control wiring and power wiring between the MicroTurbine and the DMC.
2. Make sure the load is disconnected.
3. With the grid power OFF, wire the grid terminals to the Breaker, and the Breaker to the DMC line terminals. Make sure that the A, B, C, and G conductors are all properly connected.
4. Simulate GC Ready:
   a) Verify the M1 Contactor slider switch is set for electrical operation.
   b) On the front panel of the DMC set S1 to POWER ON position and S2 to AUTO.
   c) Turn the Breaker ON.
   d) Using the DMM, verify that M1 Contactor inside DMC closes and the line voltage is available on the secondary side (load and MicroTurbine side) of the M1 Contactor.
   e) Verify the word “ON” appears in the (small) window on the M1 Contactor.
   f) Using the DMM, measure continuity between pins 1 and 2 on the DMC terminal and measure OPEN between pins 1 and 3.
   g) Shut OFF the disconnect breaker (line power).

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

5. Simulate SA Ready:

NOTE	Use an external 12 or 24 VDC power supply (MicroTurbine UCB may also be used).

   a) Install a jumper wire between pins 9 and 10 on the DMC terminal.

   b) Connect the external power supply (+) to pin 6 and power supply (-) to pin 5.

   c) Power up the external power supply to provide 12 or 24 VDC to the DMC.

   d) Verify the word “TRIP” appears on the (small) window on the M1 Contactor.

   e) Using the DMM, verify that there is no continuity between L1 and M1, L2 and M2, and L3 and M3, that is, no continuity between the primary and secondary of the M1 Contactor.

   f) Using the DMM, measure continuity between pins 1 and 3 on the DMC terminal, and measure OPEN between pins 1 and 2.

   g) Shut the power supply OFF.

   h) Disconnect the jumper wire between pins 9 and 10 on the DMC.

6. Repeat the Simulate GC Ready and Simulate SA Ready tests as required to verify the DMC operation. Once this is verified, proceed with configuring the MicroTurbine connections.

Pre-Operational Procedures

CAUTION	Perform the following procedures with the fuel supply OFF and the power supply OFF.

1. GC/SA Interlock:

   a) Model C30 - Install Operation Mode Jumper on printed circuit board terminals in the Communications Bay, i.e., TB4 (fourth terminal strip from left), pins 1 and 2 (from bottom) for Grid Connect and pins 1 and 3 for Stand Alone. For Dual Mode, remove all jumpers from pins 1, 2, and 3 and replace with appropriate Dual Mode control wiring.
   In MutiPac configurations, the GC and SA interlocks are required on the Master unit only. For Dual Mode, remove all jumpers from pins 1, 2, and 3 on the Master unit and replace with appropriate Dual Mode control wiring.

   b) Model C60 - Install Operation Mode Jumper on printed circuit board terminals in the Communications Bay, i.e., J12 (fourth terminal strip from right), Pins 3 and 5 (from bottom) for Grid Connect and pins 2 and 5 for Stand Alone. For Dual Mode, remove all jumpers from pins 2, 3, and 5 and replace with appropriate Dual Mode control wiring.
   In MutiPac configurations, the GC and SA interlocks are required on the Master unit only. For Dual Mode, remove all jumpers from pins 2, 3, and 5 on the Master unit and replace with appropriate Dual Mode control wiring.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

2. Access Components:
   a) Model C30 Standard Package - Release the latches and pull the cart out of the enclosure.
   b) Model C30 Industrial Package or Model C60 - Remove the upper and lower side panels.

Fuel System

1. Check Fuel Connections:
   a) Model C30 Standard Package - Verify that the fuel connections on the engine, fuel control and cart interface are tight.
   b) Model C30 Industrial Package or Model C60 - Verify that the fuel connections on the engine and fuel control are tight.
2. Inspect the fuel lines inside the enclosure for kinks or abrasions.

CAUTION	The gas line must be purged before the main MicroTurbine interconnect to ensure that any contaminants in the fuel supply line have been removed.

   a) Open fuel manual shut-off valve to the MicroTurbine.
   b) Check fittings for leaks (inlet through injectors) with non-flammable leak detecting fluid or gas detector.
   c) Set regulator (if installed) to ensure the fuel supply pressures are in accordance with Capstone specifications in the MicroTurbine Fuel Requirements Technical Reference (410002).
   d) Close fuel manual shutoff valve.
   e) Purge gas line to the MicroTurbine.
3. Restore Components
   a) Model C30 Standard Package: Close and latch the cart into position in the enclosure and verify that the exhaust flapper can open freely without binding or restriction.
   b) Model C30 Industrial Enclosure or Model C60: Replace the upper side panels.

Integrated CHP System

Open the bleed valve to remove any air from the heat exchanger core before operation. Close the bleed valve tightly upon completion.

Electrical Measurements

Grid Connect systems: Are voltages from the three phases and the neutral to ground between 360 and 528 VAC? ☐ Yes

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Power-on Tests

NOTE	Record all of the following settings on the Commissioning Checklist (460006).

1. Grid Connect: Close disconnect and interconnect breaker.
   Stand Alone: Close battery breaker and push 'BATT START' key on the Display Panel.
2. Verify DPC Code from Display Panel.
3. Grid Connect: Check phase voltages and frequency from the Display Panel. Verify voltages are between 360 and 528 VAC, and frequency is between 45 to 65 Hz.
4. Grid Connect: Adjust Grid Connect Protective Relay Function settings as required (in accordance with the utility interconnection agreement).
5. Stand Alone or Dual Mode: Adjust output voltage and frequency settings as required.
6. Stand Alone or Dual Mode: Adjust Stand Alone Protective Relay Function settings as required.
7. Adjust fuel index settings as required.
8. Configure any other site-specific settings as required.

Operational Procedures

WARNING	Do not ever start the MicroTurbine with the fuel supply OFF.

1. Open the manual fuel shut-off valve.
2. Grid Connect: Set power output demand to maximum. Initiate a START. Verify the MicroTurbine starts and loads normally.
   a) Check fittings for leaks from injectors back to the inlet (check injectors first while cold). Tighten fittings as required.
   b) Reset the regulator output pressure as per section 2c of the Fuel System (see Pre-Operational Procedures). This should be performed approximately two minutes after the MicroTurbine lights (output should be above 20 kW for Model C30 or above 40 kW for Model C60). This will ensure that the engine is near maximum fuel flow for this final adjustment of the pressure regulator.
   c) After a 5-minute run, initiate a STOP command. Verify that the MicroTurbine shuts down and goes into cooldown normally.
   d) Initiate a start and run at full power for 15 minutes. Verify that the MicroTurbine operates normally.
3. Stand Alone: Set the Battery breaker to OFF, disconnect loads from the MicroTurbine output terminals.
   a) Set Battery breaker to ON. Press BATT START key, Initiate a START. Wait for 'Ready To Load'.

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

b) Load enable. Check phase rotation. Is the phase rotation correct? ☐ Yes
Command system STOP. Wait for 'Standby'.

c) Set Battery breaker to OFF and wait five minutes for voltage to dissipate. Reconnect loads. Set Battery breaker to ON. Initiate a START, Wait for 'Ready to Load'. Load enable. Verify the MicroTurbine loads normally. If no Grid Connect configuration exists, perform Steps 2a through 2d from above.

4. At the completion of the above procedures, perform an equalization charge on the battery pack.

Operator Training

1. Present the end user (owner/operator) with the User's Manual (400000) shipped with the system.
2. Utilize the following sections in the User's Manual to provide training to the end user:
   a) Safety Information
      - Provide general safety precautions regarding electrical, fuel, exhaust, and acoustics of the MicroTurbine including any site-specific details, breaker and shutoff locations.
   b) Performance
      - Provide expected performance for power output, efficiency and emissions. Include derating information based on site elevation and ambient conditions.
   c) Operating the MicroTurbine
      - Basic Start/Stop and Power Demand operation
      - Use of Display Panel
      - Use of application specific display panel options based on included accessories (Dual mode of operation, Battery Management, Load Following, etc)
   d) MicroTurbine Preventive Maintenance
      - Scheduled Maintenance
      - Battery Pack maintenance required by the user/operator
   e) Troubleshooting
      - Incident Names and Codes
      - Viewing Incident Records
      - Basic Troubleshooting Procedures
   f) Warranty
      - Provide details of warranty terms and conditions
      - Review Capstone's Extended Warranty Offerings
   g) Product Support
      - ASP Contact Information

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

Submit the Commissioning Checklist

Submit a signed copy of the Commissioning Checklist (460006) to Capstone within 30 days of commissioning for activation of warranty terms.

Responsibility

It is the responsibility of Capstone to make these procedures available to the Authorized Service Providers so they can successfully complete this task.

It is the responsibility of the Authorized Service Providers to read this document, understand its contents, and effectively complete the commissioning procedures.

It is the responsibility of the Authorized Service Providers to perform the procedures in this document before completing the MicroTurbine Commissioning Checklist (460006).

This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.